New results on HLT

towards understanding of MET

SUSY

Higgs (invisible, H-> 2τ->2j, H^+-> $\tau\nu$-> J)

γ + Jet for calibration

CPU analysis of HLT JetMet selections

News on off-line Jet reconstruction

jet merging/splitting with MidPoints

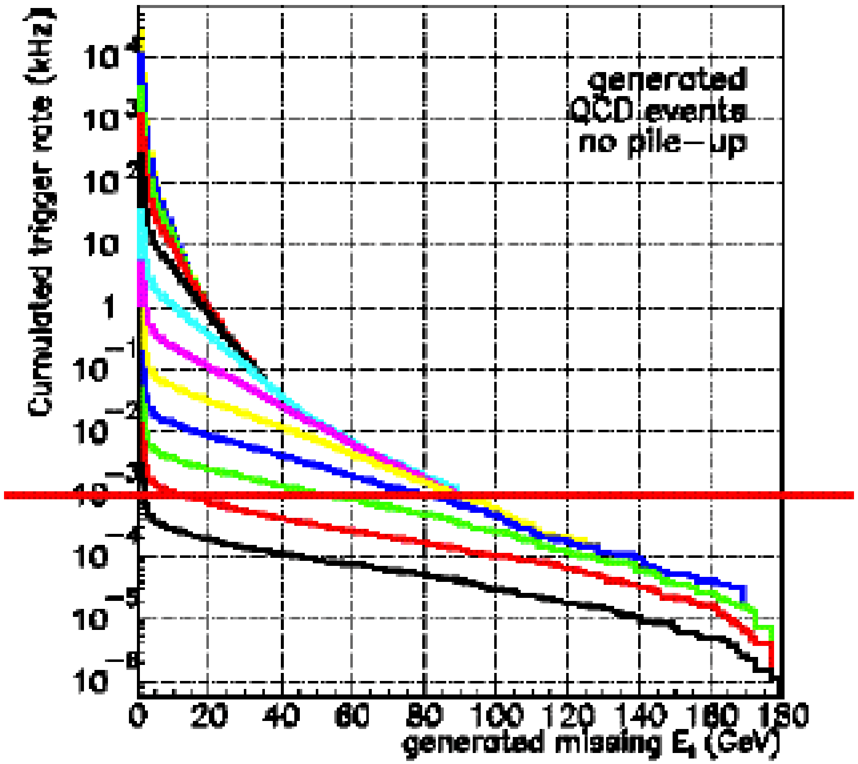
algorithm for high luminosity

adding tracks to jet (ORCA study)

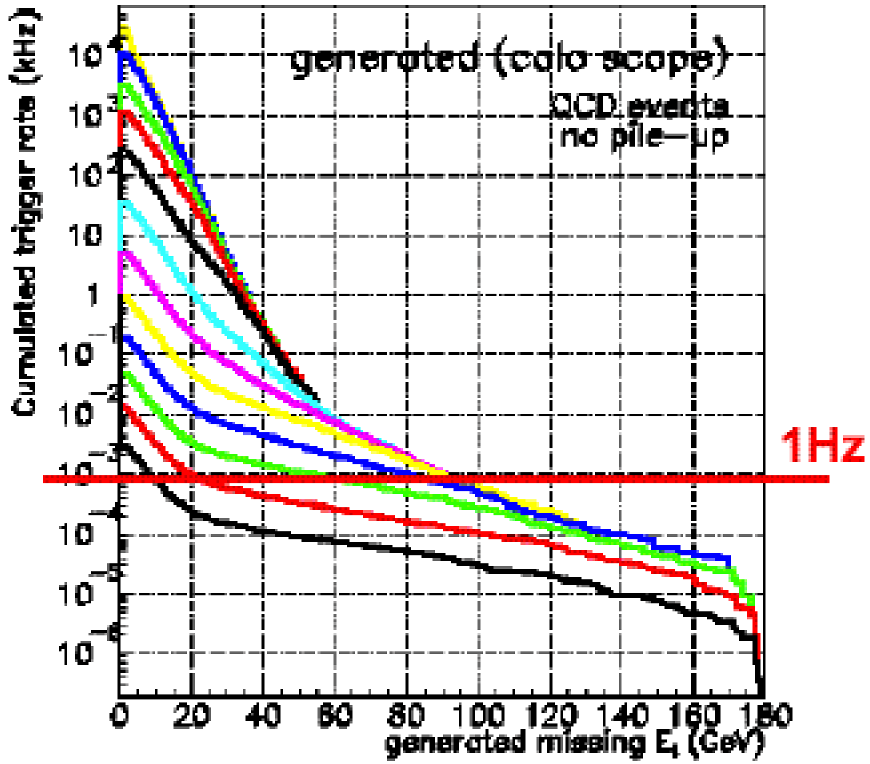
towards understanding of MET (I). P. Hidas, S. Kunori

QCD jets: MET Rates
Generated Particle Level

ν, μ excluded



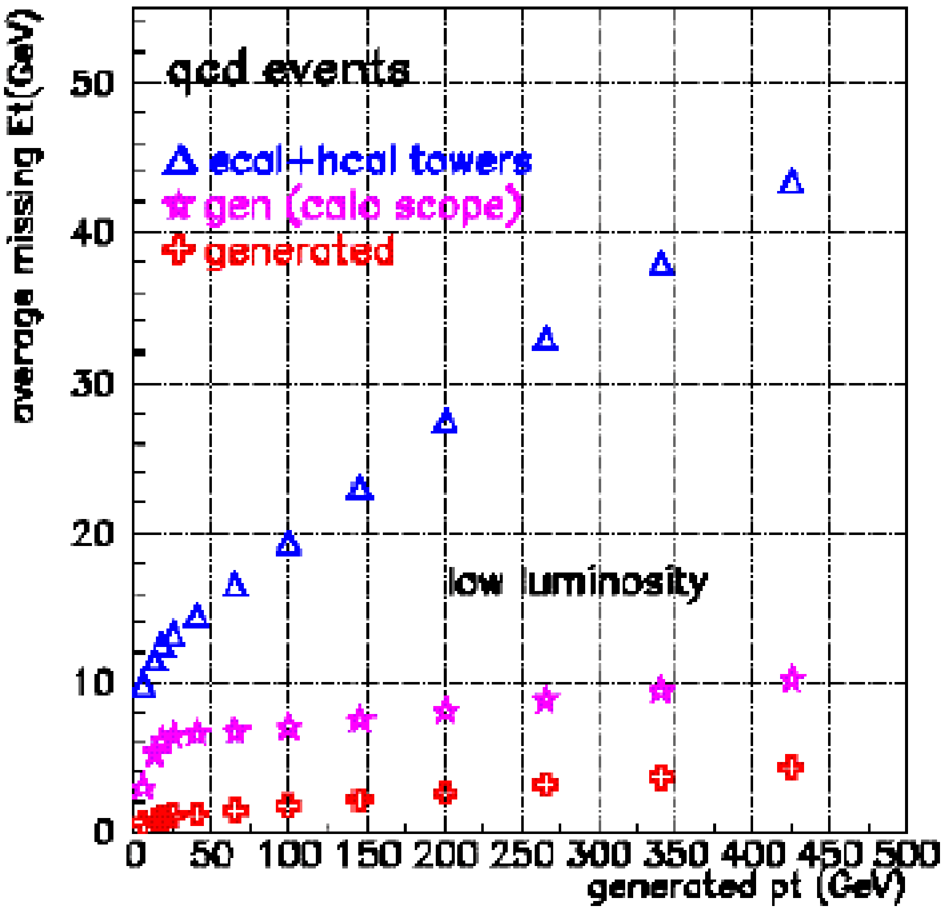
η < 5 (ν, μ excluded)



at MET > 90 GeV the low limit of rate due to physics ~ 1 Hz

towards understanding of MET (II). P. Hidas, S. Kunori

MET resolution



QCD Bins (P_T-hat)

reconstructed

detector response

$\eta < 5$

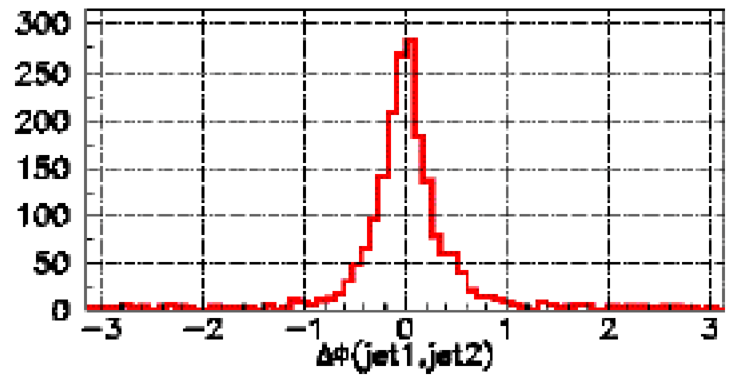
detector acceptance

ν, μ excluded

heavy flavours

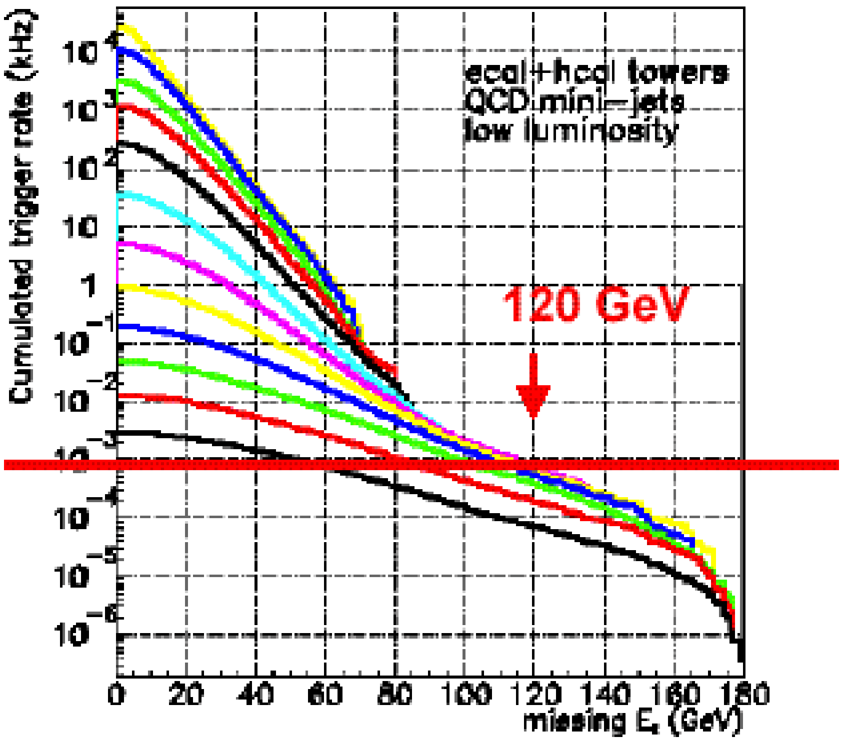
towards understanding of MET (III). P. Hidas, S. Kunori

$\Delta\phi_{j1j2}$ cut at HLT allows to setup lower MET thr. with the same rate

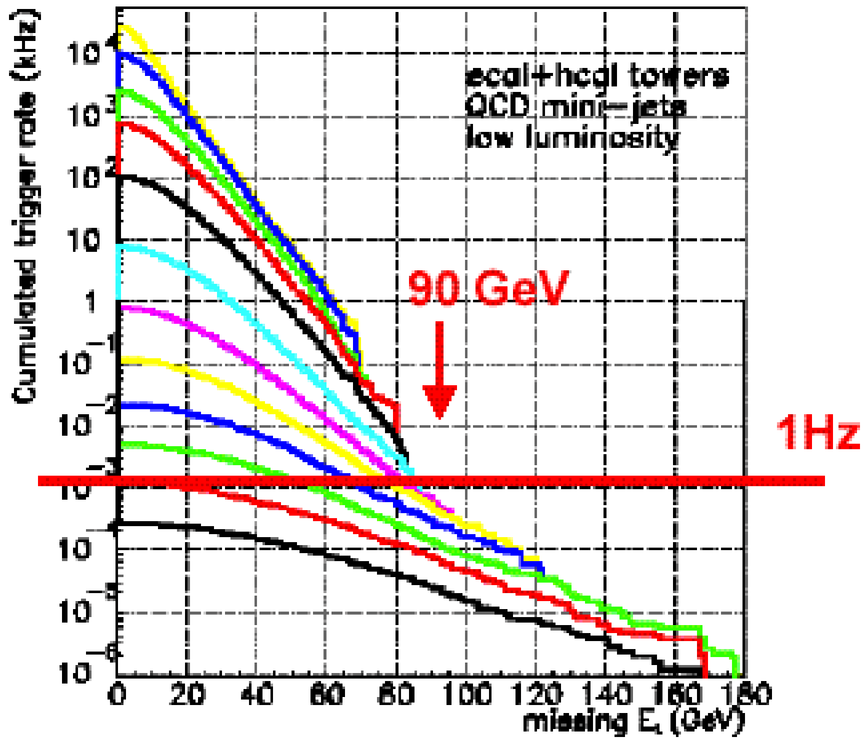


No $\Delta\phi(1,2)$ cut

$\Delta\phi(1,2)$ cut



MET Threshold

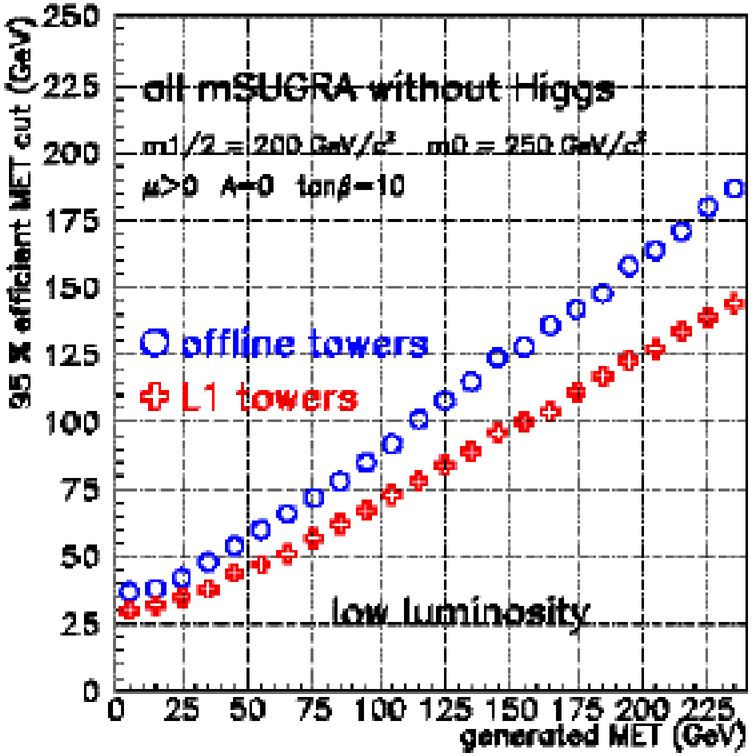


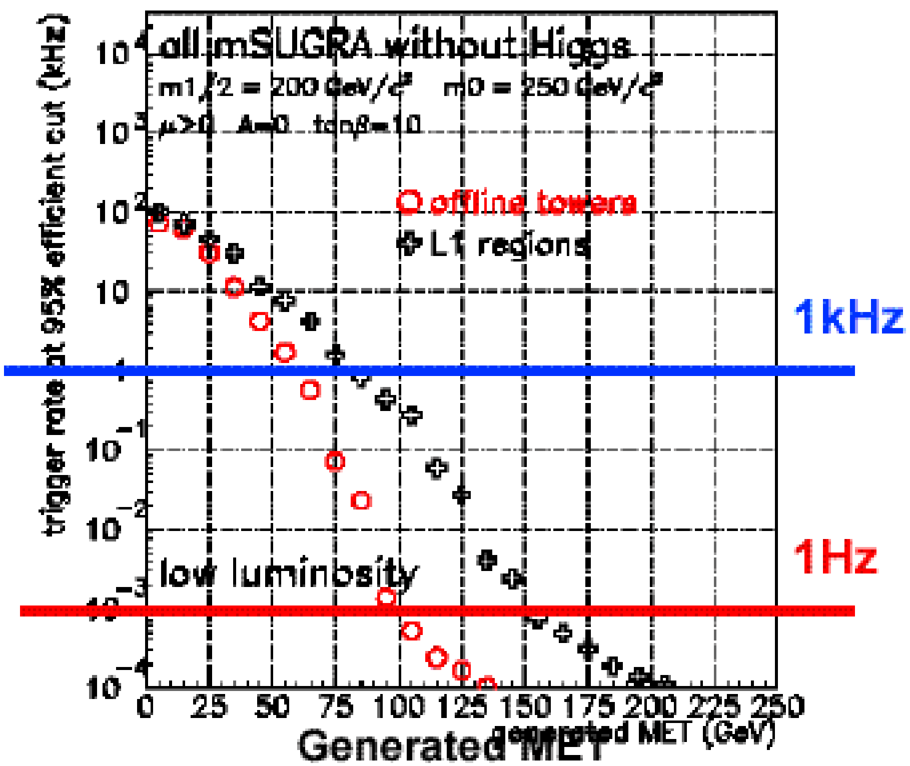
MET Threshold

towards understanding of MET (IV). P. Hidas, S. Kunori

mSUGRA1

Trigger rates with 95% efficiency
as a fucc of generated MET

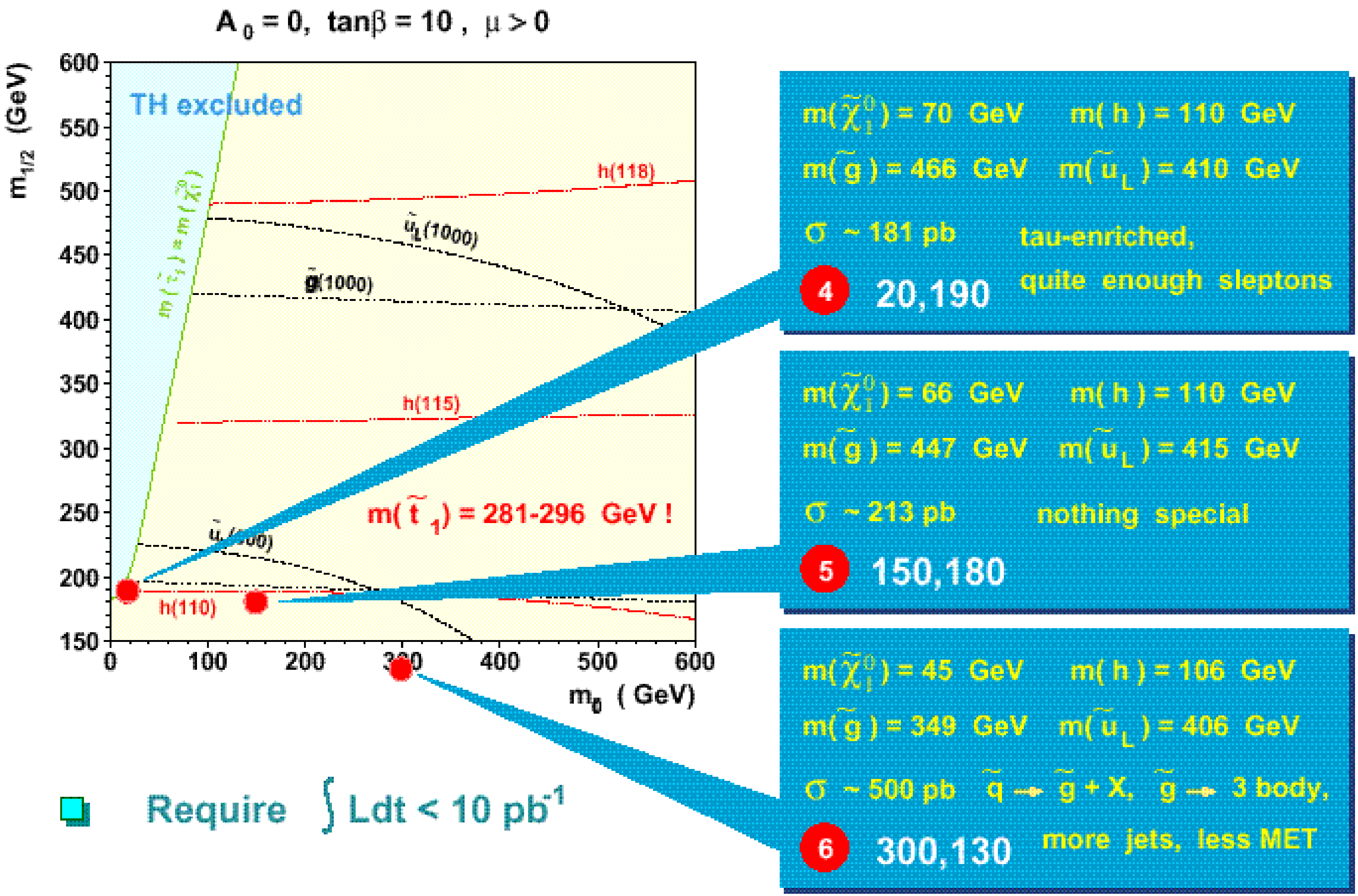




still need to understand why L1 MET resolution is so much worse than L2 MET resolution

HLT for SUSY where the Tevatron reach ends (I) S. Abdullin

H.Baer et al., hep-ph/9802441; Phys.Rev.D58:075008, 1998



Plus the same poins but with R-parity violation :

χ_0^1**(m = 45-70 GeV) -> 3 q ==> softer MET + additional soft jets**

HLT for SUSY where the Tevatron reach ends (II) S. Abdullin

HOW HIGH RATE COULD WE AFFORD

- Something like ~ 4 kHz for Jets/MET @ L1 (?)
    - 2 + 2 for tau physics and other jets/MET channels
- Something like ~ 6 Hz for Jets/MET @ L2 (?)
    - 3 + 3 for tau physics and other jets/MET channels
- Assuming 3 Hz at our disposal :
    - MET + 1-2 jets m(gluino) >> m(squark)
    - MET + 3-4 jets m(gluino) ~ m(squark)
    - 4 or more jets and small MET m(gluino) < m(squark) or $\cancel{R}$-parity
- As we don't know what the SUSY might look like, probably we should try to cope with "everything" ...

HLT for SUSY where the Tevatron reach ends (III) S. Abdullin

L1 trigger cuts optimization with genetic algorithm :

MET or J1 or J2 or J3 or J4 or J1&MET

Jets and MET E_T cuts (GeV) for optimal signal effficiency @ L1

		MET	J1	J2	J3	J4	J1 + MET
		90	190	150	70	50	80 + 70
signal efficiency (%)	Point 4	71.4(71.4)	81.7(64.8)	82.5(42.5)	86.5(50.2)	86.8(31.5)	89.7 (79.3)
	Point 5	67.4(67.4)	79.2(65.2)	80.5(45.4)	85.6(54.2)	86.4(35.4)	89.4 (78.0)
	Point 6	40.8(40.8)	60.1(47.7)	62.2(33.8)	74.1(57.2)	75.3(42.9)	78.9 (55.5)
	Point 4R	32.6(32.6)	77.6(74.7)	81.2(65.3)	90.5(83.2)	91.4(69.9)	92.1 (46.0)
	Point 5R	21.7(21.7)	76.9(75.4)	80.2(65.9)	91.6(84.4)	92.2(71.1)	92.7 (35.3)
	Point 6R	14.1(14.1)	55.0(53.5)	60.0(47.0)	81.8(75.8)	84.0(64.8)	84.5 (24.0)
Background rate (kHz)	QCD	0.05(0.05)	0.69(0.65)	0.77(0.27)	1.70(1.20)	1.79(0.34)	2.01 (0.31)
	$t\bar{t}$, W j ($l\nu$)	irrelevant !					

HLT for SUSY where the Tevatron reach ends (IV) S. Abdullin

L2 trigger cuts optimization with genetic algorithm (for events passed L1) :

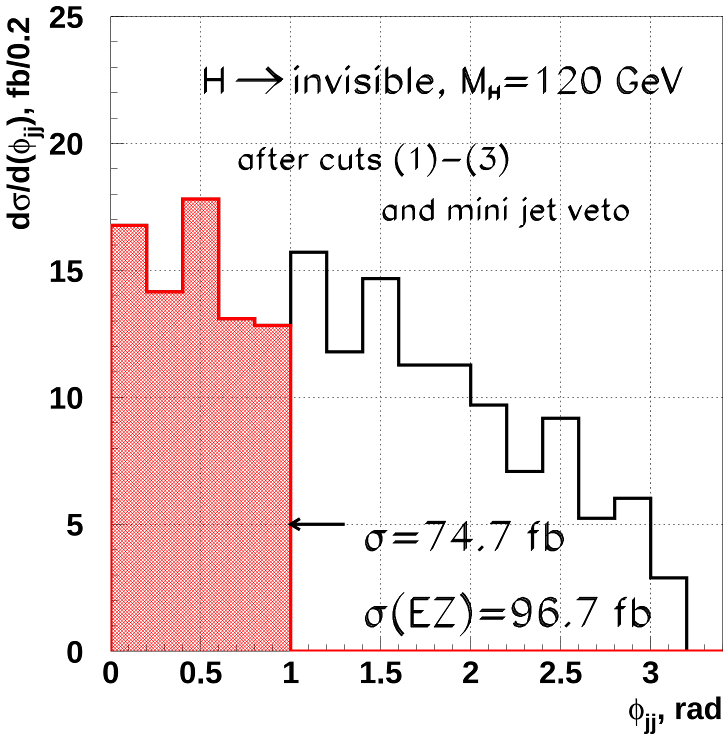
[MET or J1 or J2 or J3 or J4 or J1&MET] AND $\Delta\phi_{j1j2} < 125^0$

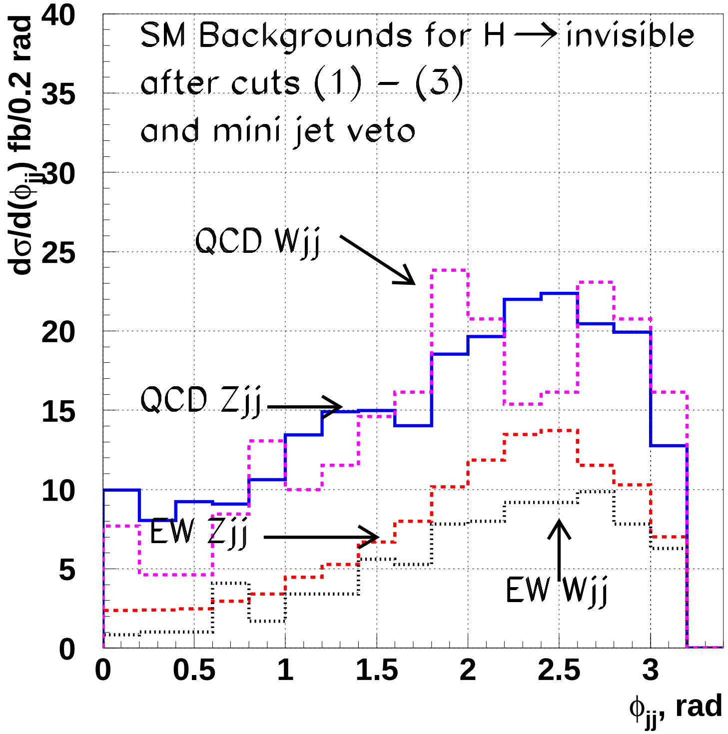
		MET 140	J1 + MET 210 + 0	J2 + MET 150 + 0	J3 + MET 30 + 100	J4 + MET 50 + 70	eff. w.r.t. L1 $\Delta\phi$ (J1,J2) < 125°	L2 rate (Hz)
signal efficiency w.r.t. L1 (%)	Point 4	45.0(45.9)	58.6(42.1)	60.8(31.1)	65.4(49.8)	66.0 (24.3)	0.704*	0.21
	Point 5	38.8(38.8)	54.3(42.5)	56.3(32.4)	61.1(46.4)	62.5 (27.0)	0.685	0.24
	Point 6	19.5(19.5)	42.8(34.8)	47.1(28.7)	53.6(32.7)	57.5 (29.1)	0.698	0.45
	Point 4R	7.1(7.1)	49.8(49.0)	55.2(44.6)	56.6(16.0)	58.6 (21.3)	0.692	0.20
	Point 5R	3.6(3.6)	52.7(52.6)	58.0(47.0)	58.6(10.0)	59.8 (15.7)	0.719	0.24
	Point 6R	2.0(2.0)	36.4(36.0)	42.9(34.9)	43.6(5.5)	45.5 (10.0)	0.708	0.38
Background rate (Hz)	QCD	0.01(0.01)	1.16(0.68)	2.10(1.79)	2.15(0.12)	2.35 (0.37)	0.098	
	$t\bar{t}$	0.03(0.03)	0.03(0.01)	0.04(0.01)	0.08(0.01)	0.09 (0.03)	0.343	
	$W j (l\nu)$	0.06(0.06)	0.07(0.04)	0.08(0.01)	0.09(0.02)	0.09 (-)	0.695	
					Σ	2.53		

is it possible to reject already at L1 the events rejected at HLT ?

HLT for Higgs (I) qq->qqH, H-> invisible A. Nikitenko, K. Mazumdar

HLT cut for SUSY search : $\Delta\phi_{j1j2} < 125^0$ is not acceptable for H->invisible



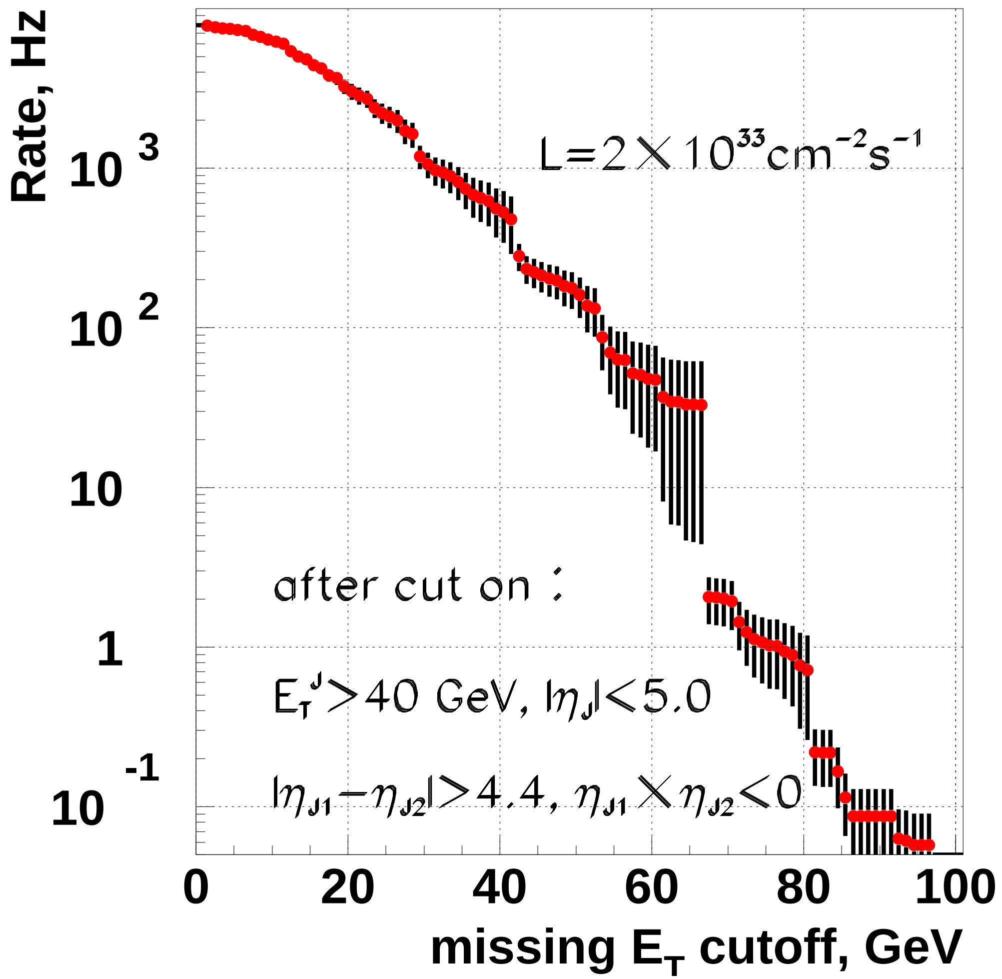


We will use events in 1.0 < $\Delta\phi_{j1j2} < \pi$ region for bkg. prediction in the "signal" region $\Delta\phi_{j1j2}$ < 1.0. (O.J.P.Eboli and D. Zeppenfeld, Phys.Lett B495 (2000) 147)

HLT SUSY cut $\Delta\phi_{j1j2}$ < 2.18 will reject 50 % of such events. It should be either relaxed or we may use WBF topological HLT selections

(next slide)

HLT for Higgs (II) qq->qqH, H-> invisible A. Nikitenko, K. Mazumdar



WBF topological selections at HLT + L2 MET > 85 GeV cut is 100 % efficient for off-line useful events and rate is only 0.1 Hz. So, we may use at L2 :

SUSY cuts (2.5 Hz) OR inv. Higgs cuts (0.1 Hz)

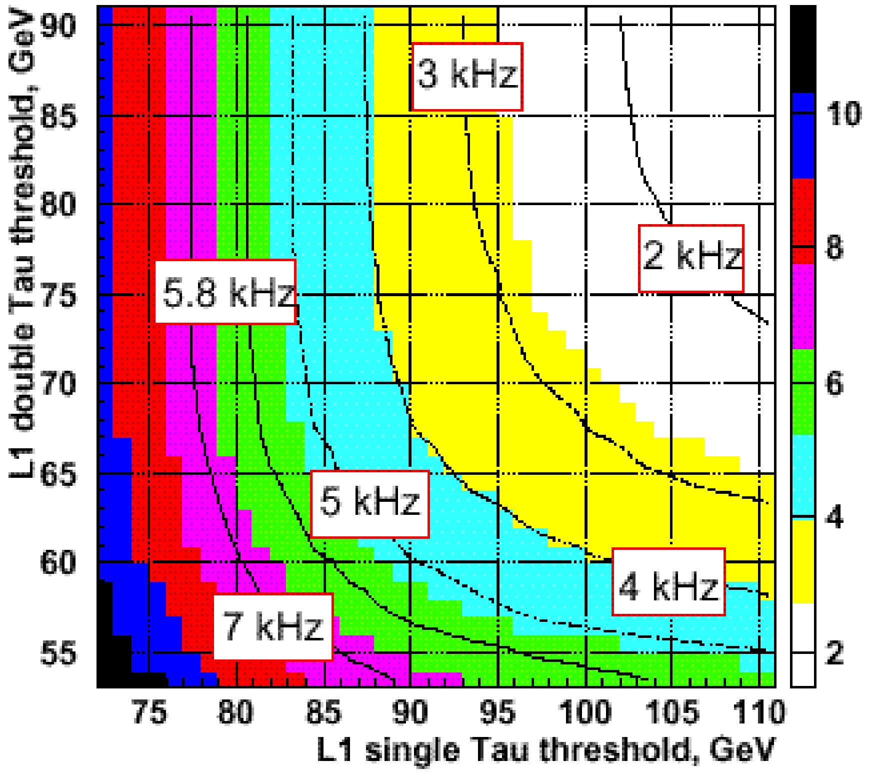
L1 & HLT for Higgs (III). Summary on tau channels A. Nikitenko

L1 for H->2τ->2jet and H^+->τ-jet

efficiency of tau signals at 3.0 kHz L1 rate of 1T or 2T

L1 threshold, GeV		efficiency	
1Tau	2 Tau	H->2τ-jets M=200 GeV	H^+->τ-jet M=200 GeV
105	64	(0.54) 0.75	0.79
103	65	(0.56) 0.75	0.80
100	67	(0.60) 0.76	0.82
98	69	(0.63) 0.76	0.82
95	75	(0.68) 0.75	0.83
93	80	(0.71) 0.74	0.84
92	90	(0.72) 0.72	0.84

number in parenthesis for H->2tau is efficiency for single L1 Tau trigger

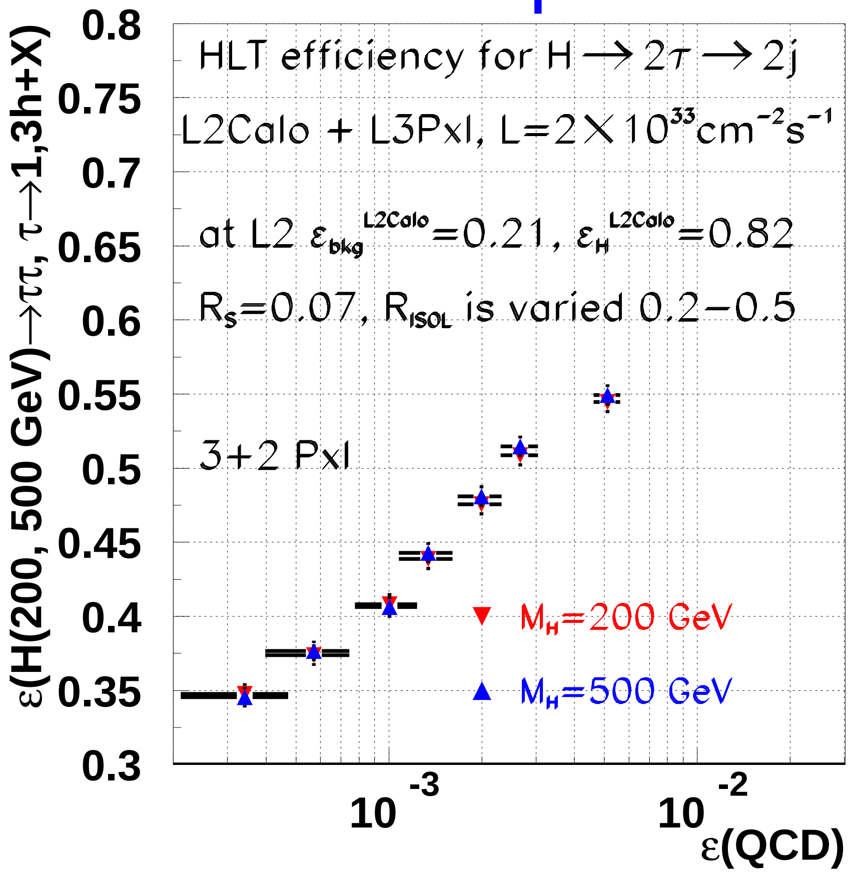


L1 & HLT for Higgs (IV). Summary on tau channels

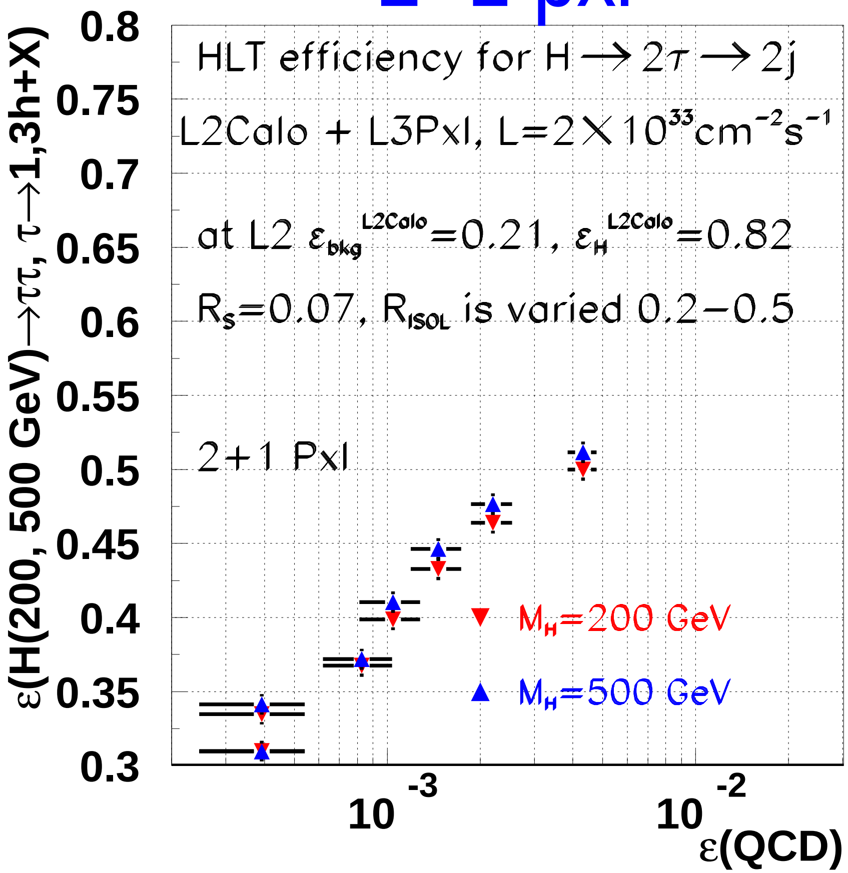
A. Nikitenko

HLT selections for H->2τ->2j with calo and pixel data

3+2 pxl



2+1 pxl



1. Performance of Calo+Pxl Tau ID is the same for 3+2 vs 2+1 pixel configuration, while for Tau ID with Pxl only (no calo id) 2+1 gives 2 times bigger rate at the same efficiency (see yestarday summary on taus on b/tau meeting)
2. with 3+2 pxl configuration Calo+Pxl and only Pxl Tau ID can provide rejection 1000 with similar efficiency - 0.40 for Calo+Pxl and 0.43 for only Pxl

L1 & HLT for Higgs (V). Summary on tau channels

A. Nikitenko

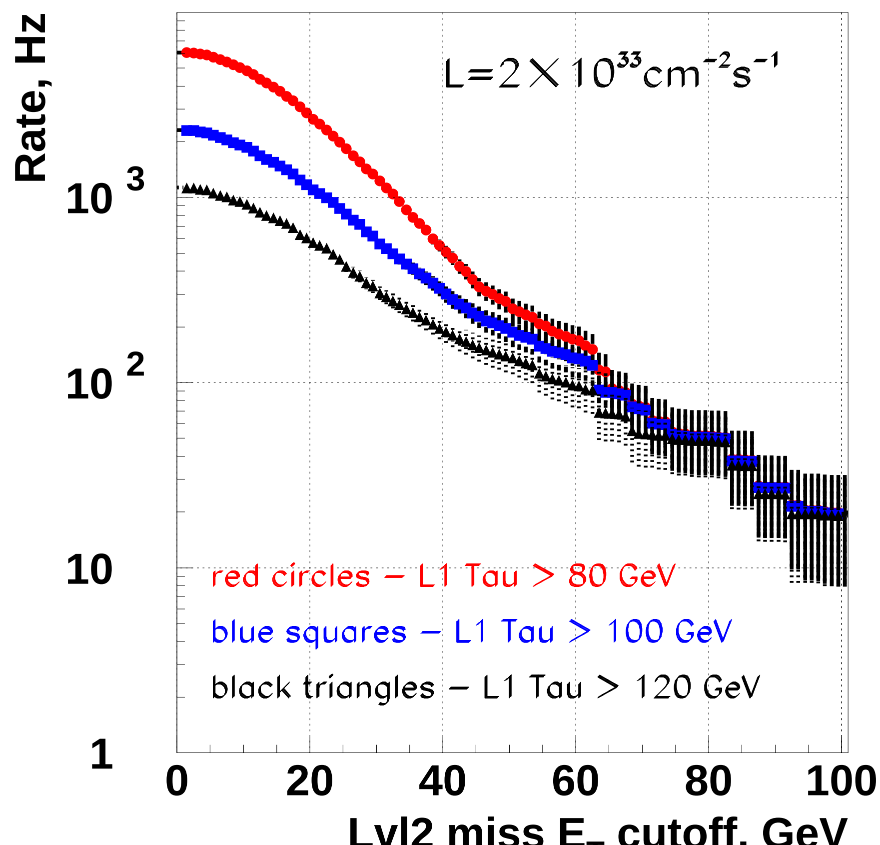
HLT selections for H->τν->jet with MET and Tracker

A. Nikitenko. L2 MET

Off-line uses E_T^{miss} > 100 GeV

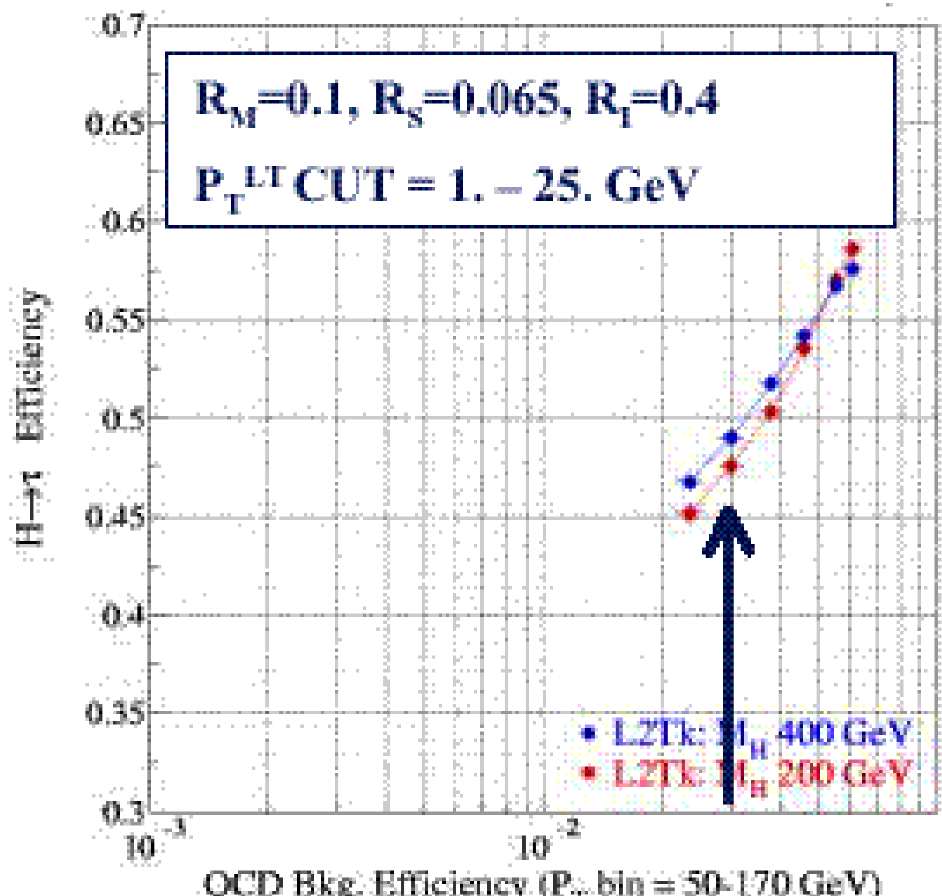
Let's do it at L2 :

L2 MET > 90 GeV, rate ~ 30 Hz
no loss of "useful" events



S. Gennai, Pisa. HLT Tracking

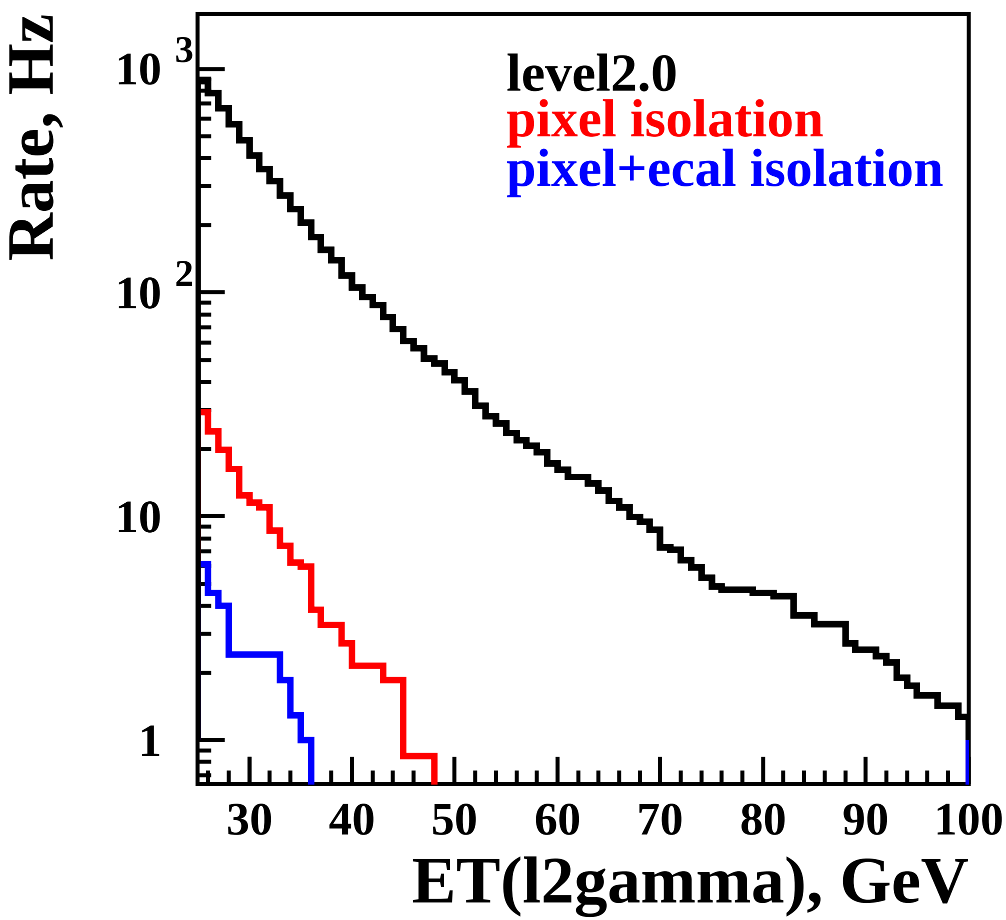
Off-line uses tracker isolation and p_t^{tr} / E_T > 0.8. Let's do at HLT : isolation + cut on p_t^{tr} we need rejection > 30 .



HLT for γ + Jet for calibration A. Oulianov (ITEP)

qcd rate in EB

(e/γ group samples are used)



1. use e / γ L 2.0 candidates

2. usage of pixels

- ***reconstruct all pixel lines and vertices***
- ***use only lines from signal vertex* for isolation criteria :***

no lines in cone 1.0 around e/ γ candidate

3. use isolation in ecal of e / γ candidate.

After 1, 2, 3 the rate is ~ 1 - 2 (mc. stat. error) Hz at E_T > 35 GeV.

The rate of γ + Jet is expected to be about the same order, will be estimated soon.

* signal vertex is a vertex with max $\Sigma p_T^{\text{pxl line}}$

CPU estimates for jet+met at HLT
for $L=2x10^{33}cm^{-2}s^{-1}$

Estimates for

global L2 jet finding + MET for SUSY

regional L2 jet finding for Higgs with tau’s

pixel reconstruction for γ + Jet HLT

made with Pentium III (Coppermine), cpu MHz : 600 MHz

CPU at L2 for global jet reconstruction, MET from E+H towers and regional L2 Jet reco for H->2tau->2j case

TimeMe reports from ORCA(message, counts, real cpu time)	qcd 50-80	qcd 120-170	H 500 GeV	H 200 GeV
SUSY events : Jet reconstruction in the entire calorimeter with iterative cone 0.5 , seed threshold 1 GeV* MET reconstruction from ecal+hcal towers.				
Reconstructing_EcalPlusHcalTowerBuilder 1000 201.610 seconds (cpu)	0.200 s/ev**			
Reconstructing_allJets 1000 215.850 seconds (cpu)	0.014 s/ev	0.014 s/ev	0.012 s/ev	0.012 s/ev
L2 MET calculation from towers 1000 5.420 seconds (cpu)	0.005 s/ev			
Tau events : Regional Jet reconstruction for H->2tau->2Jet. Only towers used in cone 0.8 around L1 Tau candidates. Iterative. cone 0.6, no seed threshold				
Reconstructing_1stL1tau 1000 3.710 seconds (cpu)	0.008 s/ev	0.009 s/ev	0.008 s/ev	0.008 s/ev
Reconstructing_2ndL1tau 839 3.510 seconds (cpu)				
Reconstructing_1stL1Cjet 211 0.790 seconds (cpu)				

* doesn’t include time on Jet energy corrections. should be negligible

** E+H tower building time is huge probably due not optimal Cell navigation : matching of every (not empty) crystal to tower requires :

- calculation of crystal position every time but not usage of hardwared positions
- usage of HcalTowerBase::GetClosestCell which loop over all eta’s and depths

better to use “matching” table (similar to EE trigger towers). how to do this ? we asked V. Litvin

Summary on JetMet HLT CPU

for Pentium III (Coppermine), cpu MHz : 600 MHz

JetMet HLT with L = 2 x 10^{33} $cm^{-2}s^{-1}$ data

time to build towers ~ 200 ms / ev **!!!**

time for SUSY (global jet finding + MET) ~ 20 ms / ev

time for Taus from Higgs (regional jet finding) ~ 8 ms / ev

~90 % of total time is taken to build towers.
this has to be reduced with smart navigation.

time to do pixel Rhits (3+2 pxl) ~ 60 ms/ev **(qcd 120-170)**

time to reconstruct lines /vertices ~ 60 ms/ev **(qcd 120-170)**

Off line news (I). Jet merging / splitting will be in ORCA 6

H.-P. Wellisch has implemented for ORCA 6 Jet finding with Jet merging / splitting and with addition of Midpoints. It is seed-based algorithm or ILCA (Improved Legacy Cone Algo) with E-Scheme, or 4-vector recombination as it was proposed for Tevatron Run II.

We would like also to have Tevatron Run I algo : seed-based algo with merging/splitting but without adding of Midpoints

At HLT we will continue to use iterative cone algo without jet merging/splitting since it's very fast and a number of jet analysed at HLT is not big (<= 4)

We plan to implement Jet finding with known vertex from Pixels

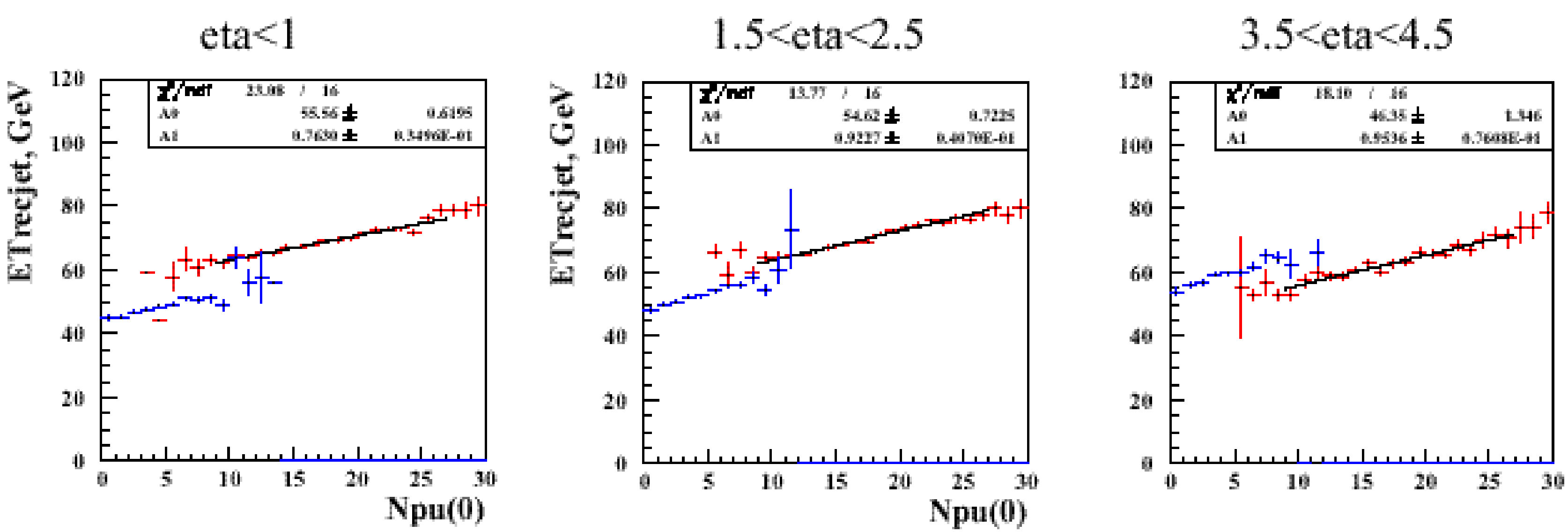
We need people to test merging/splitting algorithm implementation in ORCA

Off line news (II). Jet finding algorithm with pile up subtraction has been tested with ORCA. A. Oulianov

First fortran implementation come from CMS Heavy Ion people of Moscow State University. We wanted to try it for Jet finding with pp data at high luminosity.

before pile up subtraction :

Average response to particle jets 50GeV<ET<70GeV as a function of the number of intime pile-up events at low and high luminosity. Calorimeter jets are reconstructed with the conesize R=0.7 without pile-up subtraction.



Pile up subtraction :

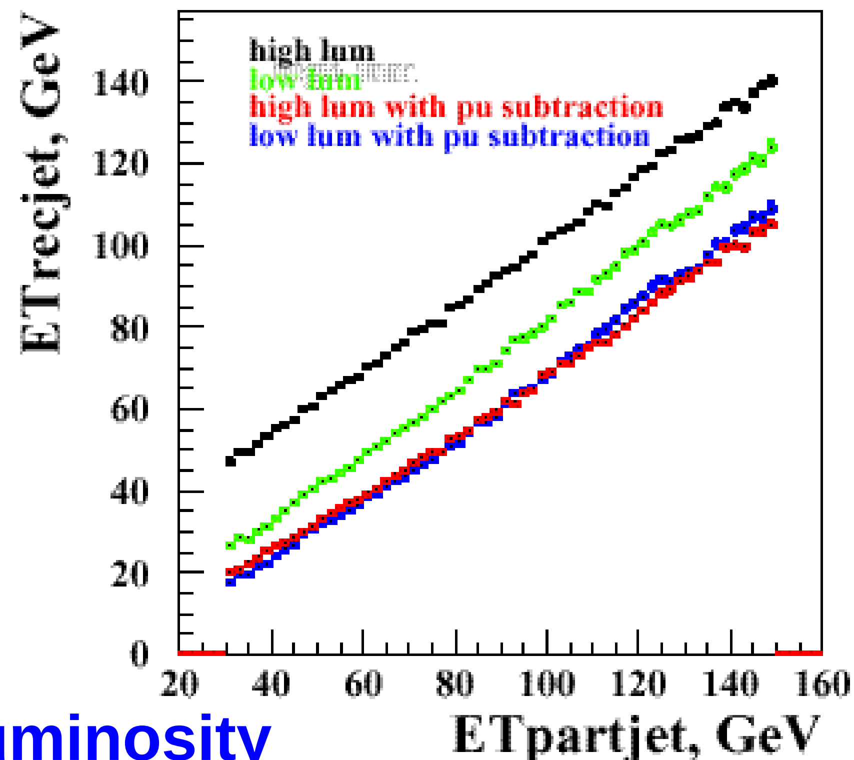
E_T^{tower} new = E_T^{tower} - <$E_T^{tower}(\eta)$> - k $D_T^{tower}(\eta)$,

where D is dispersion

<$E_T^{tower}(\eta)$> and $D_T^{tower}(\eta)$ are defined on event by event basis with towers not used by Jets.

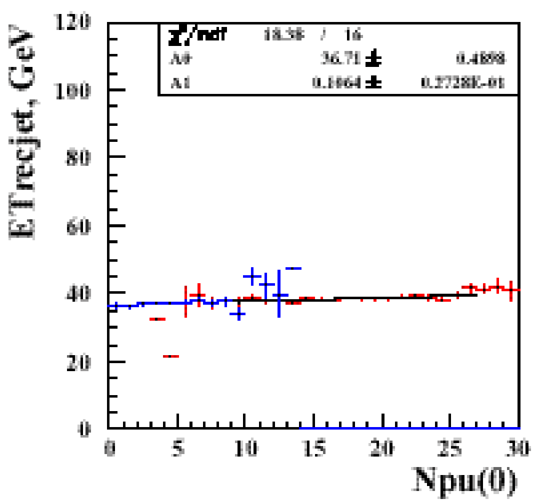
k is parameter, here k=1.

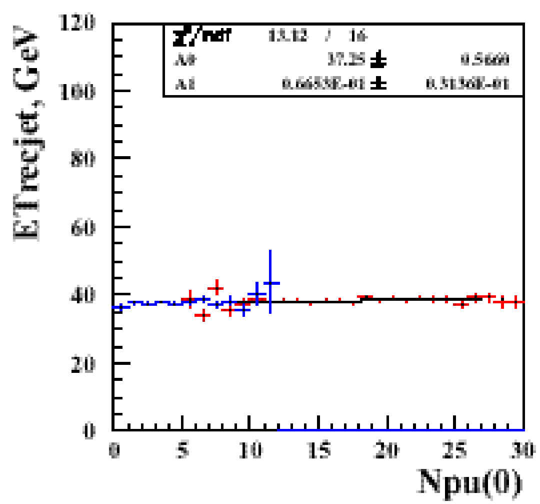
if E_T^{tower} new < 0, use zero

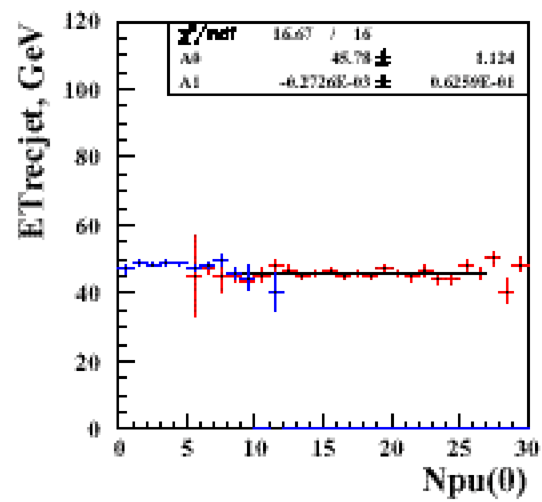


After subtraction

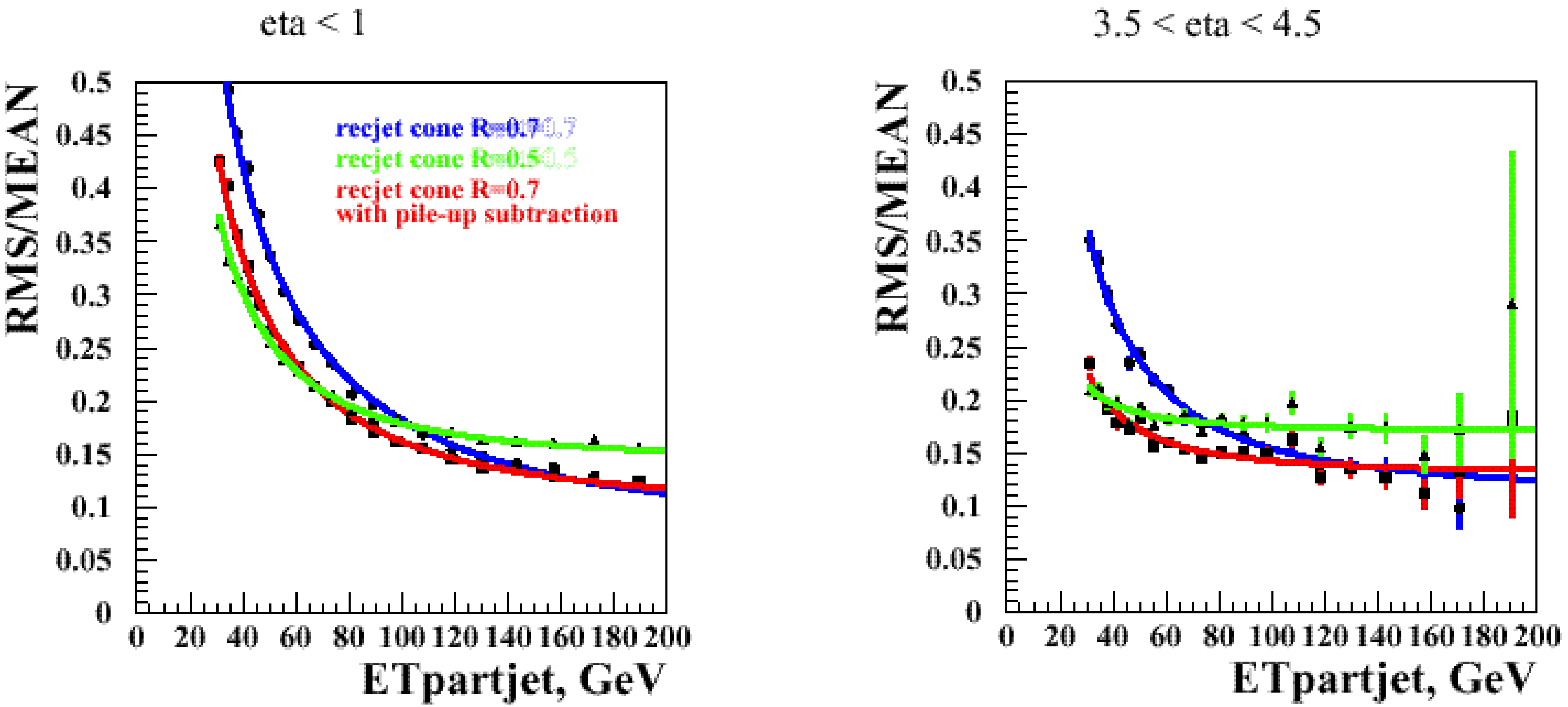
$E_T^{J\ reco} / E_T^{J\ mc}$ doesn't depend on luminosity







Jet E_T resolution is improved for Jets < 100 GeV



More questions :

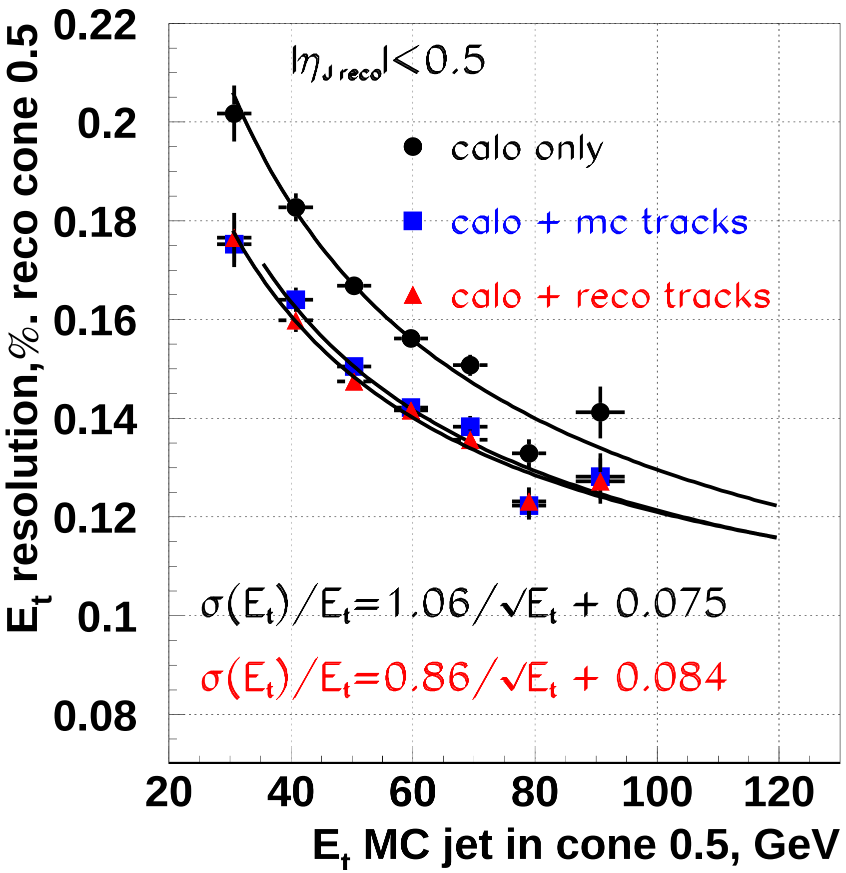
How does it works for multi - jet final states ?

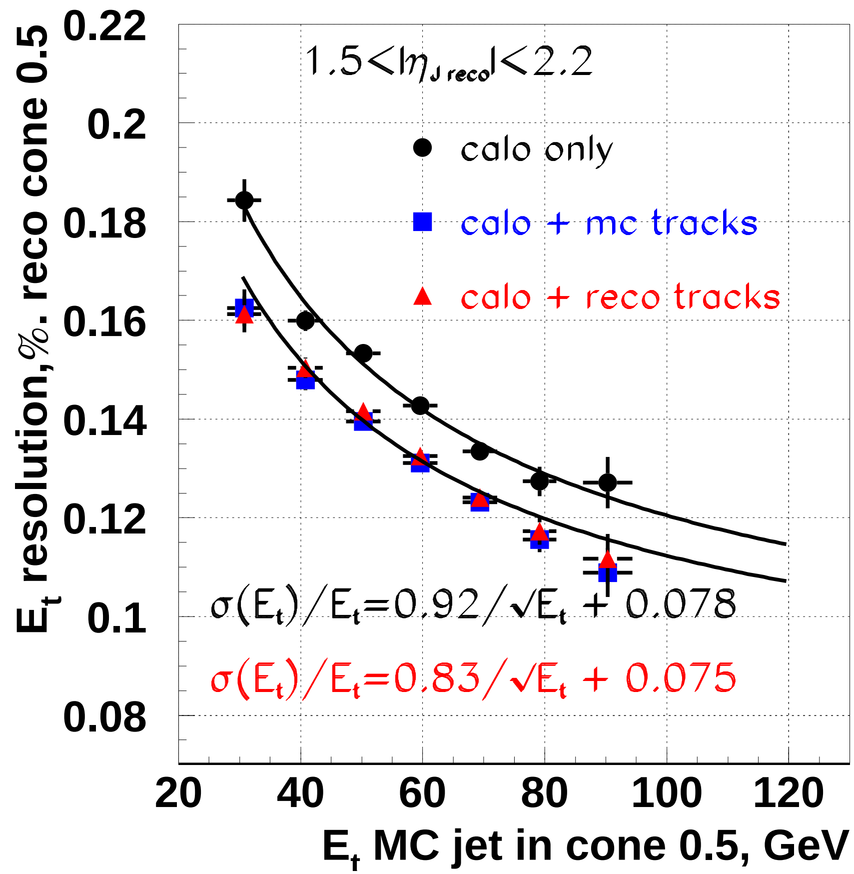
How it may suppress fake jets ?

How it may affect soft jets reco efficiency ?

Off line news (III). Towards energy flow in ORCA.

Step 1 - adding tracks deflected by magnetic field out of reco cone on the surface of calorimeter - has been tested with ORCA qcd 2-jet events and with reconstructed tracks. A. Nikitenko





energy flow and subtraction of the expected responce of charged hadrons we plan to test with ORCA by the next CMS week.

THE END